

## Quasiparticle Relaxation in a High- $T_c$ Superconductor

Recent measurements by Eesley *et al.* [1] of transient reflectivity in superconducting  $\text{ThBa}_2\text{Ca}_2\text{Cu}_3\text{O}_{10}$  were interpreted as evidence for order-parameter relaxation in the vicinity of  $T_c$ , which was analyzed in terms of BCS weak coupling for  $\Delta(T)/\Delta(0)$ . In this Comment we question this interpretation based on experimental evidence that laser pulse heating can mask the effect. Eesley *et al.* have shown [1] that the relaxation time  $\tau_s$  in the superconducting state increases dramatically as  $T_c$  is approached; a similar increase was observed previously in  $\text{YBa}_2\text{Cu}_3\text{O}_7$  [2,3] and in  $\text{Bi}_2\text{Sr}_2\text{Ca}_2\text{Cu}_2\text{O}_{10}$  [3]. From a detailed temperature dependence at various power levels Eesley *et al.* inferred [1] that in the temperature range  $(T_c - T)/T_c \leq 0.15$  the relaxation time varies as  $\tau_s \propto T\Delta(T)^{-1}$  with a BCS-type  $\Delta(T)/\Delta(0)$ , similar to that in the usual low-temperature superconductors [4]. Because their relatively thick sample had a broad transition (onset at 120 K and zero resistance at 106 K), a clean divergence of  $\tau_s$  was not observed at  $T_c$ ; inhomogeneities were claimed to contribute to this slow rise in  $\tau_s$  near  $T_c$ .

In this Comment we show that the divergence of  $\tau_s$  near  $T_c$  in a clean thin film is extremely sharp at low laser intensities. We measured the induced reflectivity  $\Delta R(t)$  at 625 nm with 60 fsec time resolution on  $\text{YBa}_2\text{Cu}_3\text{O}_7$  films, 3000 Å thick with  $T_c \approx 89$  K and width of 2 K, epitaxially deposited by the uv laser ablation technique [2]. The samples were carefully handled and they were cooled only once through the phase transition; the average laser power was lower than 1 mW. For such a sample  $\tau_s$  is proportional to the time  $\tau_{1/2}$  it takes  $\Delta R(t)$  to decay to half its initial value; we therefore show in Fig. 1 the behavior of  $\tau_{1/2}$  as a function of temperature at various laser intensities. The onset of the divergence in  $\tau_{1/2}$  shifts toward  $T_c$  as the intensity is reduced. Moreover, the *shape* of  $\tau_{1/2}(T)$  changes at low illumination levels. The divergence of  $\tau_{1/2}(T)$  is extremely sharp and sets in at  $(T_c - T)/T_c \leq 0.025$  with our lowest intensity, contrary to the data presented in Ref. [1]. A similar effect of laser heating in  $\text{YBa}_2\text{Cu}_3\text{O}_7$  was observed [5] in the gradual sharpening of the 340-cm<sup>-1</sup> phonon softening with decreasing  $T$  below  $T_c$ , measured by Raman scattering, as the laser intensity was reduced. On the basis of the evidence presented above we therefore question the dependence of  $\tau_s$  on  $T_c - T$  in Ref. [1] and their conclusion of  $\tau_s \propto T\Delta(T)^{-1}$ . Careful measurements at very low laser intensities have to be made on clean sam-

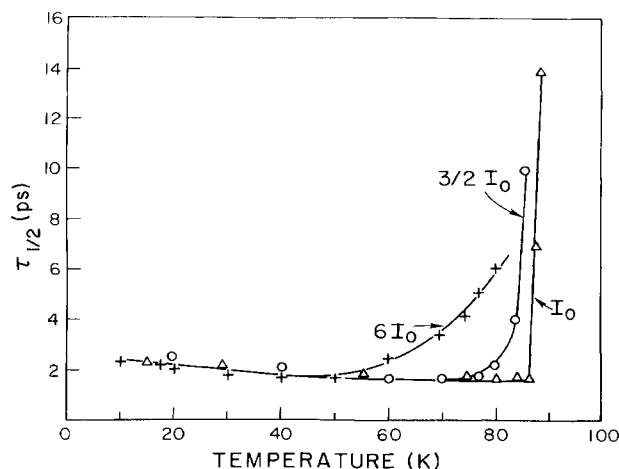


FIG. 1. Temperature dependence of quasiparticle relaxation time  $\tau_{1/2}$  in  $\text{YBa}_2\text{Cu}_3\text{O}_7$  at three different laser excitation intensities with  $I_0 = 0.5 \mu\text{J cm}^{-2}$  per pulse.

ples to verify this important relation. Moreover, if this relation were true, then our measurements shown in Fig. 1 indicate a much sharper  $\Delta(T)/\Delta(0)$  than that expected for BCS; in fact, it is more in line with *strong coupling*.

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